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Crop Profile for Peach in Canada, 2013

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Preface

National crop profiles are developed under the Pesticide Risk Reduction Program (PRRP), a joint program of Agriculture and Agri-Food Canada (AAFC) and the Pest Management Regulatory Agency (PMRA). The national crop profiles provide baseline information on crop production and pest management practices and document the pest management needs and issues faced by growers. This information is developed through extensive consultation with stakeholders.

Information on pest management practices and pesticides is provided for information purposes only. No endorsement of any pesticide or pest control technique discussed is implied. Product names may be included and are meant as an aid for the reader, to facilitate the identification of pesticides in general use. The use of product names does not imply endorsement of a particular product by the authors or any of the organizations represented in this publication.

For detailed information on growing peach, the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile.

Every effort has been made to ensure that the information in this publication is complete and accurate. Agriculture and Agri-Food Canada does not assume liability for errors, omissions, or representations, expressed or implied, contained in any written or oral communication associated with this publication. Errors brought to the attention of the authors will be corrected in subsequent updates.

Agriculture and Agri-Food Canada gratefully acknowledges the contributions of provincial crop specialists, industry specialists and growers in the gathering of information for this publication.

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Contents

Crop Production 2
Industry Overview 2
Production Regions 2
North American major and minor field trial regions 3
Cultural Practices 5
Abiotic factors Limiting Production 7
Temperature 7
Soil 7
Water 7
Diseases 8
Key issues 8
Brown Rot *(Monilinia fructicola)* 17
Bacterial Spot (*Xanthomonas arboricola* pv. *pruni*) 18
Coryneum Blight *(Wilsonomyces carpophilus)* 19
Peach Scab *(Cladosporium carpophilus)* 19
Peach Leaf Curl (*Taphrina deformans*) 20
Powdery Mildew *(Podosphaera pannosa)* 21
Bacterial Canker *(Pseudomonas syringae)* 22
Peach Canker (Cytospora Canker, Valsa Canker, Perennial Canker) (*Leucostoma cincta* and *Leucostoma persoonii*) 22
Verticillium Wilt *(Verticillium dahliae)* 23
Crown Gall *(Agrobacterium tumefaciens)* 24
Phytophthora Root Rot and Crown Rot (*Phytophthora* spp.) 25
Plum Pox Virus (Sharka) (PPV) 26
Rhizopus Rot (*Rhizopus* spp.) 27
Insects and Mites 28
Key issues 28
Oriental Fruit Moth (OFM) (*Grapholita molesta*) 39
Plum Curculio *(Conotrachelus nenuphar)* 40
Green Peach Aphid (*Myzus persicae*) 41
Brown Marmorated Stinkbug (BMSB) (*Halymorpha halys*) 42
Tarnished Plant Bug (TPB) (*Lygus lineolaris*) 43
European Red Mite (*Panonychus ulmi*) 44
Two-Spotted Spider Mite (*Tetranychus urticae*) 45
Peach Silver Mite (*Aculus cornutus*) 45
Comstock Mealybug *(Pseudococcus comstocki)* 46
San Jose Scale *(Quadraspidiotus perniciosus)* 47
Japanese Beetle (*Popillia japonica*) 48
Obliquebanded Leafroller (*Choristoneura rosaceana*) and other Leafroller Species 48
European Earwig *(Forficula auricularia)* 49
Spotted Wing Drosophila (*Drosophila suzukii*) 50
Western Flower Thrips (WFT) Frankliniella occidentalis) 51
Peach Tree Borer *(Synanthedon exitiosa)* 51
Lesser Peach Tree Borer (*Synanthedon pictipes*) 52
Peach Twig Borer (*Anarsia lineatella*) 53
Spring Feeding Caterpillar Complex (Redbanded Leafroller (*Argyrotaenia velutiana*), Variegated Leafroller (*Platynota flavedana*), Fruittree Leafroller (*Archips argyrospila*), Eastern Tent Caterpillar (*Malacosoma americanum*), Forest Tent Caterpillar (*M. disstria*), Eyespotted Bud Moth (*Spilonota ocellana*) and Gypsy Moth (*Lymantria dispar*)) 54
Weeds 55
Key Issues 55

Weeds 62
Vertebrate Pests 64
Resources 65
IPM/ICM resources for production of peach in Canada 65
Provincial Crop Specialists and Provincial Minor Use Coordinators. 66
National and Provincial Fruit Grower Organizations 66
Appendix 1 67
References 68

List of Tables and Figures

Table 1. General production information 2
Table 2. Distribution of peach production in Canada (2013) 3
Table 3. Peach production and pest management schedule in Canada 6
Table 4. Occurrence of diseases in peach production in Canada 9
Table 5. Adoption of disease management practices in peach production in Canada 10
Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada 12
Table 7. Occurrence of insect pests in peach production in Canada 29
Table 8. Adoption of insect pest management practices in peach production in Canada 30
Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada 32
Table 10. Pheromone products registered on peach in Canada 38
Table 11. Occurrence of weeds in peach production in Canada 55
Table 12. Adoption of weed management practices in peach production in Canada 56
Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada 58

Figure 1. Common zone map: North American major and minor field trial regions 4

Crop Profile for Peach in Canada

Peach (*Prunus persica* var. *persica*), a member of the rose family, is native to China and was introduced into Europe 2,000 years ago. It was first brought to North America in the 16th century by Spanish explorers.

The nectarine, *Prunus persica* is a closely related fruit. Peach and nectarine trees do not differ in appearance, growth response, bearing habit or other general characteristics. Nectarines are distinguished from peaches by their smaller size, greater aroma, distinct flavour and absence of pubescence. Throughout this document, all descriptions, practices, growth stages and activities refer to both peaches and nectarines unless otherwise stated.

Peaches are high in vitamins A, B and C and potassium. They have many uses including canned or frozen slices for desert, fruit cup cocktails, sauces, drinks, jams, pie fillings and as food flavouring in products such as yogurt. However, the largest use by far is fresh consumption. There are two main types of peaches. Clingstone peaches, so called because the flesh tends to adhere to the stone, have a firmer texture and are used for canning. Freestone peaches, in which the stone does not adhere to the flesh, are generally consumed fresh. Since the 1700's, peaches and nectarines produced in Ontario and British Columbia have been grown primarily for fresh consumption.

Crop Production

Industry Overview

Table 1. General production information

Crop	Peach	Nectarine
Canadian Production (2013)[1]	22,633 metric tonnes 2,491 hectares	3,022 metric tonnes 330 hectares
Farm gate value (2013)[1]	$34 million	$5.3 million
Fruit available in Canada 2013[2]	1.18 kg/ person (fresh) 0.70 kg/ person (canned)	0.75 kg/ person (fresh) N/A (canned)
Exports (2013)[3]	740 metric tonnes (canned)	N/A (canned)
Imports (2013)[3]	23,640 metric tonnes (fresh) 19,110 metric tonnes (canned)	24,780 metric tonnes (fresh) N/A (canned)

[1]Source: Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual, CANSIM (database). (Accessed: 2015-07-10).

[2]Source: Statistics Canada. Table 002-0011- Food available in Canada CANSIM (database). (Accessed 2015-07-10).

[3]Source: Statistics Canada. Table 002-0010 Supply and disposition of food in Canada CANSIM (database). (Accessed: 2015-07-10).

Production Regions

In Canada, the main production regions for peach and nectarine are the Niagara region of Ontario and the Okanagan Valley of British Columbia. The acreages for these crops are listed in Table 2. Small areas also exist in Nova Scotia.

Table 2. Distribution of peach production in Canada (2013)

Production Regions	Cultivated Area 2013 (hectares) (percent national production)	
	Peach	Nectarine
British Columbia	427 (17%)	75 (23%)
Ontario	2,046 (82%)	255 (77%)
Nova Scotia	F	F
Canada	2,491 (100%)	330 (100%)

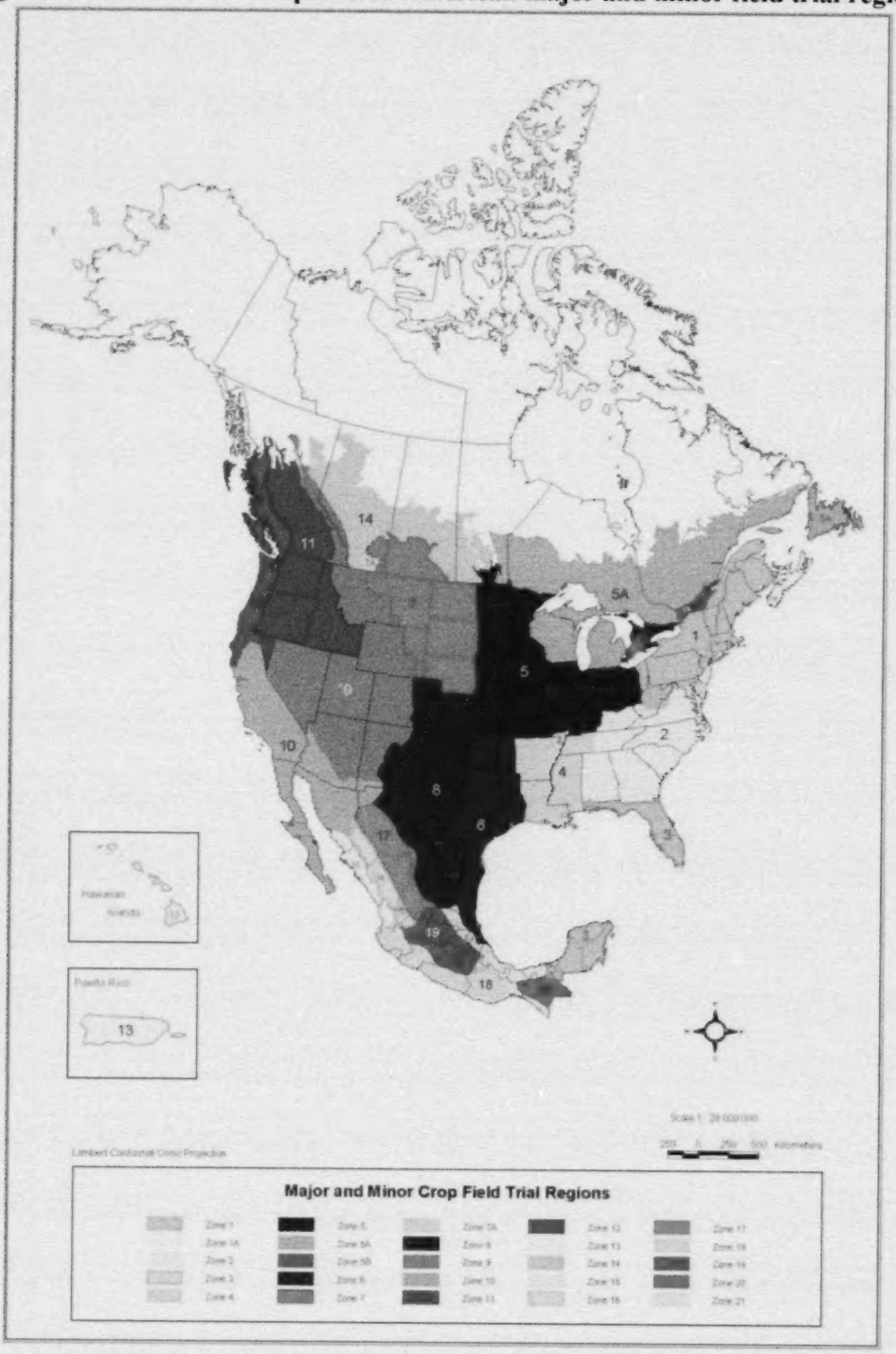
[1]Source: Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual. CANSIM (database) (accessed: 2015-07-10).

F Too unreliable to be published.

North American major and minor field trial regions

Major and minor crop field trial regions (figure 1), are used by the Pest Management Regulatory Agency (PMRA) in Canada and the United States (US) Environmental Protection Agency (EPA) to identify the regions where residue chemistry crop field trials are required to support the registration of new pesticide uses. The regions are based on a number of parameters, including soil type and climate but they do not correspond to plant hardiness zones. For additional information, please consult the PMRA Regulatory Directive 2010-05 "*Revisions to the Residue Chemistry Crop Field Trial Requirements*" (www.hc-sc.gc.ca/cps-spc/pubs/pest/_pol-guide/dir2010-05/index-eng.php).

Figure 1. Common zone map: North American major and minor field trial regions[1]



[1]Produced by: Spatial Analysis and Geomatics Applications, Agriculture Division, Statistics Canada, February 2001.

Cultural Practices

Peaches grow best on sites that are protected from spring frosts and that have deep, well-drained, sandy loam soil. South facing slopes of about four to eight percent that allow good air exchange and surface water run-off during heavy rains and have the greatest exposure to the sun, are the most suitable planting sites. Since peaches in Canada are grown at the northern limit of production, sites should be located within three to four kilometres of a body of water, for temperature moderation to protect against frost and extreme cold during the winter. Properly designed wind breaks are also used to reduce winter damage and raise temperatures. Peach trees grown on standard Bailey rootstock normally produce commercial crops for 15 to18 years. Once the orchard is removed, it is recommended that the soil be fumigated for nematodes. Soil tests are done in the fall and adjustments to nutrients or pH are done in the spring. The ideal pH of soil for peach and nectarine orchards is between 6 and 6.5.

Land preparation includes installing tile drainage, since peach trees cannot tolerate wet soils. Sites are ploughed in the fall, cultivated, limed and managed for weeds before planting. If the season permits, a fall green cover crop is planted to build up organic matter. Peach tree planting takes place in the spring (usually mid-April) when soil temperatures rise and there is still good moisture in the soil. Trees are planted when dormant and the buds typically break two weeks later. Before planting, crown or root galls are pruned off. Standard rootstocks are used and densities are normally 201 trees per acre (18 x 12 foot spacing). Trees are typically branched when planted, but are pruned to four to five feet high with about six to ten shoots that are each two to three buds in length.

Proper pollination is essential for good fruit quality. Peaches are self-fertile and do not require a pollinizing variety to be located within the orchard. Peaches bear fruit on one year-old wood so heavy pruning is needed each year to produce a good crop.

Thinning of fruit must be done by hand. Thinning can improve the size of the remaining fruit and the crop load, as well as increase the amount of bloom that will occur the following season.

Leaf analysis is the most reliable method to determine tree nutrient needs. Nitrogen is applied in the late fall or early spring. Excess nitrogen leads to poor fruit colour and poor storage quality and should be avoided. Fertigation (the addition of fertilizer to irrigation water) is an area of growing interest and research in tree fruit production.

Irrigation is critical for peaches during the growing season (April to July). After harvest, trees are thoroughly watered before being allowed to dry out for the winter. Irrigation is done with under-tree micro-sprinklers, overhead sprinklers or drip irrigation.

Fruit is hand-picked to ensure fruit quality. Skilled workers climb six to eight foot ladders to pick the fruit on mature trees.

Table 3. Peach production and pest management schedule in Canada

Time of year[1,2] (growth stage)	Activity	Action[3]
November 15 – March (dormant)	Plant care	Prune trees.
	Disease management	Prune out branches with peach (cytospora) canker.
	Weed management	Monitor for weeds and apply controls if needed (B.C.).
	Other	Monitor for vertebrate pests and control as needed.
Early – mid April (swollen bud)	Insect and mite management	Spray for scale and European red mite; use of superior oil.
Mid – late April (bud burst - 1/2 inch green tip)	Plant care	Fertilizer application (nitrogen and potash), pruning, irrigation.
	Disease management	Monitor for powdery mildew, peach leaf curl, coryneum blight and brown rot; apply controls as needed.
	Weed management	Herbicide application.
May 1 – mid May (pink - petal fall, first new leaves open)	Plant care	Pruning, cultivation, brush removal.
	Disease management	Monitor for powdery mildew, peach leaf curl, coryneum blight and brown rot; apply controls as needed.
	Insect and mite management	Monitor for peach twig borer, leafrollers, fruitworms, mites, aphids, lygus bugs and beneficial organisms; apply controls as needed.
	Weed management	Monitor for weeds and apply controls as needed.
	Other	Monitor for vertebrate pests and control as needed.
May 20 (fruit set, shuck (dried floral remnants present), fully expanded leaves)	Plant care	Pruning, brush removal, cultivation.
	Disease and insect management	Spray first cover; use of insecticide.
	Weed management	Herbicide application.
June 1 - mid-August (shoot growth, fruit development and maturation, terminal buds set)	Plant care	Thin crop, seed cover crop; apply supplemental nutrient sprays as needed; irrigate as needed; do leaf analysis.
	Disease and insect management	Optional second cover spray.
	Insect and mite management	Monitor for peach tree borer, leafrollers, mites, aphids and other insects; apply controls as needed.
Mid-August to end September (fruit maturation harvest)	Disease management	Treat harvested fruit for brown rot and rhizopus rot as needed.
	Other	Hand harvest, grading and packing, irrigation only if very dry, spray.
Late September - November (leaf senescence, harvest and post-harvest care)	Plant care	Mow orchard; irrigate as needed after harvest; remove weak, dead and diseased trees; take soil samples for nutrient analyses; begin preparation of new sites for new plantings.
	Disease management	Apply post-harvest copper spray for coryneum blight and peach leaf curl.
	Weed management	Monitor for weeds and apply controls if needed.
	Other	Monitor for vertebrate pests and control as needed.

[1]The calendar of events as listed in Table 3 are for Ontario. For Nova Scotia, the dates for the events run 7 to 14 days behind those for Ontario. For British Columbia, the season is often 2 to 3 weeks ahead of Ontario.

[2]Dates are only averages and may vary depending upon weather conditions and site.

[3]Spray schedule will vary with temperature and precipitation.

Abiotic Factors Limiting Production

Temperature

In Canada, peaches and nectarines can be produced commercially in only limited areas, given their sensitivity to cold. Like most tender fruits, they are at high-risk for crop failure due to extreme weather conditions. Fruit buds are easily killed by cold winter temperatures and spring frosts. Winter injury also compounds the problem of tree decline caused by biotic factors such as borers and canker.

Soil

Peach trees must be planted in soils that have very good water percolation. Planting on poorly drained soil may predispose trees to phytophthora root rot, winter damage, low productivity or death.

Water

For sustained production and mitigation of risk, all acreage requires irrigation. Erratic weather patterns have resulted in a greater need for the industry to have access to water for irrigation. Where growers do not have access to water, losses have resulted.

Diseases

Key issues

- Resistance development in pathogen populations is becoming a concern in managing both brown rot and powdery mildew. There is a need for the registration of additional multi-site materials for improved fungicide rotations and resistance management.
- While many fungicides work best as protectants, there is a need to develop monitoring techniques and economic thresholds, and to investigate proper timing and /or combinations of sprays, to optimize management of brown rot, peach scab, peach leaf curl and powdery mildew. Prediction models for powdery mildew are also needed.
- Bacterial diseases cause serious damage in peach production and can result in premature decline of orchards. There is a need for registration of effective disease management products for bacterial spot and bacterial canker.
- Peach varieties with resistance to peach canker and plum pox virus are needed, as these will form the cornerstone of integrated disease management programs for these diseases.
- There is a need for additional fungicide registrations to replace older products which may be removed from the market for the management of diseases including coryneum blight and peach leaf curl.
- There is a need to investigate the biology of the peach scab pathogen, *Cladosporium carpophilus* under Ontario conditions, as well as cultivar susceptibilities and fungicide efficacy, as there has been an increase in presence of this disease in Ontario orchards over the past three to four years.

Table 4. Occurrence of diseases in peach production in Canada[1,2]

Disease	British Columbia	Ontario
Brown rot		
Bacterial spot		
Coryneum blight		
Peach scab		
Peach leaf curl		
Powdery mildew		
Bacterial canker		
Peach (perennial canker)		
Verticillium wilt		
Crown gall		
Phytophthora root rot and crown rot		
Plum Pox Virus (Sharka)		
Rhizopus rot (post-harvest)		

Widespread yearly occurrence with high pest pressure.
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.
Pest is present and of concern, however little is known of its distribution, frequency and importance.
Pest not present.
Data not reported.

[1]Source: Peach stakeholders in reporting provinces.

[2]Please refer to Appendix 1, for a detailed explanation of colour coding of occurrence data.

Table 5. Adoption of disease management practices in peach production in Canada

	Practice / Pest	Brown rot	Coryneum blight	Peach scab	Perennial canker	Peach leaf curl	Powdery mildew
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	choice of planting site						
	optimizing fertilization						
	reducing mechanical damage or insect damage						
	thinning / pruning						
	use of disease-free seed, transplants						
Prevention	equipment sanitation						
	mowing / mulching / flaming						
	modification of plant density (row or plant spacing; seeding rate)						
	seeding / planting depth						
	water / irrigation management						
	end of season crop residue removal / management						
	pruning out / removal of infected material before harvest						
	tillage / cultivation						
	removal of other hosts (weeds / volunteers / wild plants)						
Monitoring	scouting - trapping						
	records to track diseases						
	soil analysis						
	weather monitoring for disease forecasting						
	use of portable electronic devices in the field to access pest identification / management information						
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests						

... continued

Table 5. Adoption of disease management practices in peach production in Canada (continued)

Practice / Pest		Brown rot	Coryneum blight	Peach scab	Perennial canker	Peach leaf curl	Powdery mildew
Decision making tools	economic threshold						
	weather / weather-based forecast / predictive model						
	recommendation from crop specialist						
	first appearance of pest or pest life stage						
	observed crop damage						
	crop stage						
Suppression	pesticide rotation for resistance management						
	soil amendments						
	biological pesticides						
	controlled atmosphere storage						
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)						
New practices (by province)	timing of pruning (Ontario)						

This practice is used to manage this pest by at least some growers.

This practice is not used by growers to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]Source: Stakeholders in peach producing provinces (British Columbia, Ontario).

Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Agrobacterium radiobacter	biological	unknown	unknown	N/A	R	crown gall
Bacillus subtilis strain QST 713	microbial: *Bacillus* spp. and the fungicidal lipopeptides they produce	F6: lipid and membrane synthesis	microbial disrupters of pathogen cell membranes	44	R	brown rot
boscalid	pyridine-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	blossom blight and brown rot
boscalid + pyraclostrobin	pyridine-carboxamide + methoxy-carbamate	C2: respiration + C3: respiration	complex II: succinate-dehydrogenase + complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	7 + 11	R + R	blossom blight and brown rot , anthracnose, leaf spot, powdery mildew (suppression), rhizopus rot
captan	phthalimide	multi-site contact activity	multi-site contact activity	M4	RE	brown rot, scab
chlorothalonil	chloronitrile (phthalonitrile)	multi-site contact activity	multi-site contact activity	M 5	RE	blossom blight, brown rot and fruit brown rot, leaf curl

.... continued

Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
copper (different salts)	inorganic	multi-site contact activity	multi-site contact activity	M1	R	coryneum blight (British Columbia only), leaf curl, anthracnose
cyprodinil	anilino-pyrimidine	D1: amino acids and protein synthesis	methionine biosynthesis (proposed) (cgs gene)	9	R	brown rot blossom blight, fruit brown rot
dicloran	aromatic hydrocarbon	F3: lipid synthesis and membrane integrity	lipid peroxidation (proposed)	14	R	fruit decay (monilinia brown rot), rhizopus rot
fenbuconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	blossom blight, fruit brown rot
fenhexamid	hydroxyanilide	G3: sterol biosynthsis in membranes	3-keto reductase, C4-demethylation (erg27)	17	R	blossom blight, twig or shoot blight and brown rot caused by *Monilinia* spp.
ferbam	dithiocarbamate and relatives	multi-site contact activity	multi-site contact activity	M3	RE	leaf curl, coryneum blight (shot hole), brown rot, blossom blight

.... continued

Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
fludioxonil	phenylpyrrole	E2: signal transduction	MAP/histidine-kinase in osmotic signal transduction (os-2, HOG1)	12	RE	blue mould, grey mould, brown rot, rhizopus rot
fluxapyroxad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	blossom blight, brown rot, ripe fruit rot
iprodione	dicarboximide	E3: signal transduction	MAP/ histidine-kinase in osmotic signal transduction (os-1, Daf1)	2	RE	brown rot
lime sulphur (calcim polysulphide)	inorganic	multi-site contact activity	multi-site contact activity	M2	R	leaf curl, powdery mildew, brown rot, coryneum blight, peach blight
methyl bromide + chloropicrin (preplant soil funigant)	alkyl halide[4] + chloropicrin[4]	miscellaneous non-specific (multi-site) inhibitor[4] + miscellaneous non-specific (multi-site) inhibitor[4]	miscellaneous non-specific (multi-site) inhibitor[4] + miscellaneous non-specific (multi-site) inhibitor[4]	8A[4] + 8B[4]	PO + RES*	insects, nematodes, soil-borne fungi, certain weeds
metrafenone	benzophenone	unknown	actin disruption (proposed)	U8	R	powdery mildew

....continued

Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
myclobutanil	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	brown rot, powdery mildew
penthiopyrad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	brown rot, blossom light and fruit rot, powdery mildew, scab, botrytis rots
potassium bicarbonate	not classified	diverse	unknown	N/A	R	control / suppression of powdery mildew
propiconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	brown rot, blossom blight, fruit brown rot
pyraclostrobin	methoxy-carbamate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	anthracnose, monilinia blossom and twig blight (suppression)
quinoxyfen	aryloxyquinoline	E1: signal transduction	signal transduction (mechanism unknown)	13	R	powdery mildew (*Podosphaera clandestina* (control), *Sphaerotheca pannosa* (suppression))
sulphur	inorganic	multi-site contact activity	multi-site contact activity	M2	R	brown rot, leaf spot, scab powdery mildew
thiophanate-methyl	thiophanate	B1: mitosis and cell division	ß-tubuline assembly in mitosis	1	RE	brown rot
thiram	dithiocarbamate and relatives	multi-site contact activity	multi-site contact activity	M3	RE	peach scab, brown rot (blossom blight, fruit rot)

....continued

Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
trifloxystrobin (peach non-bearing)	oximino-acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	powdery mildew (nectarine), rhizoctonia root rot
trifloxystrobin	oximino-acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	powdery mildew (suppression), shot hole
triforine	piperazine	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	RE	brown rot (blossom blight stage)
ziram	dithiocarbamate and relatives	multi-site contact activity	multi-site contact activity	M3	RE	coryneum blight

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of March 18, 2015. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Fungicide Resistance Action Committee. *FRAC Code List 2014: Fungicides sorted by mode of action (including FRAC code numbering)* (www.frac.info/) (accessed February 17, 2015).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA Re-evaluation note REV2013-06, Special Review Initiation of 23 Active Ingredients, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

[4]Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

Brown Rot *(Monilinia fructicola)*

Pest Information

Damage: The brown rot fungus causes blossom blight, shoot dieback, twig cankers and fruit rot. Infected blossoms wilt, shrivel and die. Developing or mature fruit may exhibit a brown spot that quickly develops as a soft dry rot of the entire fruit.

Life Cycle: *M. fructicola* mycelia (vegetative strands) overwinter in infected, mummified fruit and twigs. As temperatures warm in spring, conidia (asexual spores) are produced. The conidia are dispersed by wind and rain and cause new infections. Frost injured blossoms are more susceptible to infection. Rarely, apothecia (mushroom-like sexual spore producing structures) develop on fruit mummies on the ground and release ascospores (sexual spores) during bloom. Developing fruit can be infected by conidia produced on blighted blossoms. Nectarine is more susceptible than peach and both appear to be most susceptible from pink to the shuck-fall period and two to three weeks prior to picking. Brown rot development is favoured by extended wet conditions.

Pest Management

Cultural Controls: Sanitation is essential. The following practices minimize spore populations and reduce the likelihood of an epidemic: removal of all remaining fruit and brown rot mummies from the tree after the final picking; fruit thinning carried out before pit hardening if possible; removal of infected blossoms and shoots as they occur; maintenance of a weed free herbicide strip in sod culture/high density systems to discourage the production of apothecia and ascospores; removal of abandoned blocks and wild susceptible hosts nearby.

Resistant Cultivars: Some varieties, including Babygold 5, Babygold 7, Veecling and Harrow Diamond, are more susceptible than others.

Chemical Controls: Fungicides registered for brown rot control are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Brown Rot

1. Resistance to pesticides is becoming a concern. Additional, multi-site materials are required for use in rotation to reduce the reliance on two classes of fungicides (groups one and three) for which there is the potential of resistance development.
2. There is a need to develop cost effective approaches to disease monitoring and forecasting for improved treatment decisions.

Bacterial Spot (*Xanthomonas arboricola* pv. *pruni*)

Pest Information

Damage: Bacterial spot is a serious disease of peach, nectarine, apricot, and Shiro plum. The disease attacks the fruit, leaves and current season's twigs. It can severely devitalize trees by defoliation and reduces yield and quality of harvested fruit. Early season infections result in very deep lesions in the fruit flesh, while infections within 30 days of harvest result in circular, yellowish spots. Affected peaches may be rejected by processors.

Life Cycle: Bacterial spot is of most concern in regions with annual rainfall greater than 50 cm. The disease overwinters in cankers on twigs. Bacteria are produced in the cankers in the spring and are spread by splashing rain to new leaves where they cause new infections. Frequent rainfall, winds and moderate temperatures favour infection. The bacteria multiply and are spread to developing fruit throughout the season when favourable conditions occur. The three week period following petal fall is critical for early-season fruit infection and establishment of inoculum on new foliage. Rainfall during this period is required for infection.

Pest Management

Cultural Controls: Wind breaks that prevent sand blasting of leaves and fruit can be helpful. New plantings should be located away from orchards of highly susceptible cultivars. Pruning to open up the canopy and allow more rapid drying of foliage and providing adequate fertility that does not promote excessive foliar growth or nutrient stress, results in conditions less favourable for disease development.

Resistant Cultivars: The most effective means of managing bacterial spot is through the use of more resistant cultivars. Cultivars developed in the relatively humid areas of North America possess fair to good tolerance to the disease. Cultivars developed in the drier areas are frequently too susceptible to the disease to be grown successfully in humid areas.

Chemical Controls: There are no bactericides registered for bacterial spot of stone fruits in Canada.

Issues for Bacterial Spot

1. There is a need for the development of bactericides for the control of bacterial spot.
2. Growers are concerned about the potential for rejection of affected peach fruit by processors.

Coryneum Blight *(Wilsonomyces carpophilus)*

Pest Information

Damage: The pathogen causes small spots on fruit. Frequent rainy periods at shuck fall result in more severe symptoms. Small spots that may become gummy also develop on twigs. Infections of bud tissues can result in bud death, blossom blight or shot hole symptoms on the leaves. Twig infections can result in girdling and dieback of the twig.

Life Cycle: The pathogen overwinters in buds and twig cankers. Spores produced in infected tissues are spread by rain to new bud and twig tissues where they give rise to new infections.

Pest Management

Cultural Controls: The pruning-out of infected twigs during dormancy will reduce overwintering disease. The use of drip irrigation systems that do not result in foliar wetness, is less conducive to disease development than overhead systems.

Resistant Cultivars: None identified.

Chemical Controls: Fungicides registered for control of coryneum blight are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Coryneum Blight

1. New fungicides are required to replace older products for the management of coryneum blight.

Peach Scab *(Cladosporium carpophilus)*

Pest Information

Damage: Numerous, grey-green spots, two to three mm in diameter develop on fruit. The spots eventually take on a corky appearance and may coalesce and cause cracking. This injury can lead to secondary rots or cause fruit to dry out. Spots also develop on the underside of leaves and along twigs. Severely infected leaves can drop prematurely.

Life Cycle: Conidia (asexual spores) are produced in the spring in infected one year old twigs where the pathogen overwintered. The conidia are rain splashed to fruit, foliage and growing twigs where they cause new infections. Infection of new growth can occur throughout the growing season and is favoured by the presence of free moisture and temperatures of 22 to 30°C.

Pest Management

Cultural Controls: Pruning to open up the canopy will facilitate more rapid drying of foliage and fruit and result in conditions less favourable for disease development. Monitoring for peach scab is important, especially if the disease was prevalent in the orchard the preceding year. It is important that fungicide sprays be initiated at the shuck split stage of fruit development before symptoms are apparent on the fruit.

Resistant Cultivars: None identified

Chemical Controls: Fungicides registered for peach scab are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Peach Scab

1. There is a need for further studies on the biology of the pathogen under Ontario conditions and on cultivar susceptibility as there has been an increase in the prevalence of peach scab in Ontario orchards over the past three to four years.
2. The development of an effective management strategy is required for peach scab including the identification of effective fungicides and the best timing of applications.

Peach Leaf Curl (*Taphrina deformans*)

Pest Information

Damage: The pathogen causes discolouration and curling and thickening of leaves. Affected leaves eventually wither and die and are replaced by healthy leaves. The repeated loss of leaves weakens the tree. Severe early defoliation and dieback of foliage in the spring causes crop loss on nearly all peach and nectarine cultivars. The destructive potential of peach leaf curl is frequently underestimated, resulting in important control measures being forgotten or delayed.

Life Cycle: The fungus overwinters as spores on twigs. Buds are infected in the spring as they expand resulting in curled and thickened leaves. Leaves become less susceptible to infection as they mature. New spores are produced within infected tissues and remain on the branches and twigs until the following spring when they cause new infections. Viable spores can survive on branches for several years in the absence of conditions suitable for infection.

Pest Management

Cultural Controls: Treatment is not effective once infection has occurred and symptoms appear. The efficacy of control programs can be assessed during bloom and then modified for the next season if necessary. When infection is severe, thinning more fruit than normal, reducing drought stress through irrigation and applying extra nitrogen fertilizer will help to maintain tree vigour.

Resistant Cultivars: All cultivars are susceptible to some degree. Redhaven and its derived cultivars are less susceptible.

Chemical Controls: Fungicides registered for leaf curl control are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Leaf Curl

1. The development of an accurate, predictive model would be useful to determine the need and timing of spray applications for peach leaf curl.
2. Further studies on the use of fungicides for the management of peach leaf curl including application timings, numbers of applications and product selection are needed. The registration of new fungicides is required.

Powdery Mildew *(Podosphaera pannosa)*

Pest Information

Damage: Powdery mildew attacks young shoots, leaves, and fruits. Under favourable weather conditions, the disease can reduce fruit quality, defacing the fruit with netting or white spots which increase in size until a large portion of the surface is covered. Skin eventually turns dark brown, with the surface becoming leathery and hard. As the fruit matures, it becomes more resistant to the fungus

Life Cycle: Powdery mildew overwinters in infected buds and shoots. With the onset of growth in the spring, the fungus produces conidia which are dispersed by wind and rain to expanding leaves, shoots and young fruit where they cause new infections. Warm, humid weather favours disease development. Conidia develop in the new infections and are dispersed by wind and rain to new infection sites.

Pest Management

Cultural Controls: Practices that facilitate drying of the foliage, such as pruning to promote air circulation in the canopy and reduce relative humidity, will reduce the development of powdery mildew. Irrigation should be avoided late in the afternoon or evening.

Resistant Cultivars: Peach cultivars vary in their susceptibility to powdery mildew.

Chemical Controls: Some fungicides applied for brown rot have also shown good activity against powdery mildew. Fungicides registered for powdery mildew control are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Powdery mildew

1. There is a continued need for the registration of alternative chemistries for the management of powdery mildew and for resistance management.
2. Further studies are required on the yield impact and economic thresholds of powdery mildew on different cultivars as differences in disease susceptibility have been observed. There is a need to refine prediction models for peaches and nectarines for improved management of powdery mildew.

Bacterial Canker *(Pseudomonas syringae)*

Pest Information

Damage: Bacterial canker can affect cherries, peach and other stone fruit, pears, apple rootstocks and ornamentals. Symptoms of bacterial canker include dieback of blossoms, leaf spotting and shot hole symptoms and fruit spots. Infections on trunks and limbs are often initiated at pruning sites resulting in cankers that exude a gummy ooze. Infections can lead to twig and branch dieback.

Life Cycle: The pathogen overwinters in trunk cankers and in the buds of host trees. The bacterium also survives on the surface of leaves and weeds in the orchard. The pathogen is spread by rain splashing and on pruning tools. Infections are favoured by cool, wet conditions.

Pest Management

Cultural Controls: Cultural practices that minimize stress on peach trees such as planting on good sites and providing adequate moisture and nutrients will reduce the likelihood of infection. Pruning during rainy periods or in late spring or fall when bacterial populations are highest is not recommended as these conditions favour infections. The removal of severely affected branches and trees will remove a source of disease.

Resistant Cultivars: None identified.

Chemical Controls: There are no chemicals registered for the control of bacterial canker on peach.

Issues for Bacterial Canker

1. The registration of bactericides is required for the control of bacterial canker.

Peach Canker (Cytospora Canker, Valsa Canker, Perennial Canker) (*Leucostoma cincta* and *Leucostoma persoonii*)

Pest Information

Damage: The disease results in the formation of cankers on branches that restrict the movement of water and nutrients resulting in symptoms of nutrient deficiencies, reduced growth and dieback on affected branches. Cankers on trunks can kill a tree.

Life Cycle: Canker fungi invade weakened, dying and dead tissues and through wounds. Once established, the pathogens grow into adjacent healthy tissues. The advancement of fungal growth is halted during the growing season when tree growth produces a ring of callus around the canker. Alternate periods of fungal and tree growth result in concentric rings of growth. Although the causal fungi are found primarily on peach they can also cause canker and twig dieback on nectarine, plum, prune, sweet and sour cherry, wild black cherry, choke cherry, apricot and apple. Fruiting bodies develop in the cankers and release spores. The spores are spread to wounds by rain, insects, birds and pruning tools, where they cause new infections.

In the late winter and early spring, cankers may expand due to the activity of the lesser peach tree borer. In the fall, the incidence of new cankers may be related to injury to twigs caused by the oriental fruit moth.

Pest Management

Cultural Controls: Practices that minimize winter and physical injury will help to reduce the chances of disease development. Proper site selection for new plantings is essential. Hilling of soil or mulching at the base of the tree will help water drain away and prevent cold injury to the crown. Planting new orchards away from known sources of leucostoma inoculum, such as adjacent to or downwind of older, heavily infected peach blocks, will minimize exposure to disease inoculum. Inter-planting young trees with older, diseased trees may appear economical, however the young trees will be at much greater risk and have a shorter productive life than young trees planted in solid blocks. The use of disease-free nursery stock and effective management of oriental fruit moth and peach tree borer, even in the first few non-bearing years, will help to protect young orchards from this disease. Training trees during the first season so that the branches develop wide crotch angles, necessary for long orchard life, and use of wire or plastic guards against rodent damage will also be beneficial. Pruning cuts may provide entry points for the disease however healed wounds are not susceptible to attack. As healing is temperature-dependent, pruning delayed until the first forecasts of warm, dry weather in late April or May, is less likely to cause problems.

Resistant Cultivars: None available.

Chemical Controls: There are no products available that provide suitable control for the disease.

Issues for Peach Canker

1. Effective management approaches, including the use of resistant varieties, are required for peach canker, a serious concern, as it is the major cause of decline and short life span of orchards.
2. There is a need to develop and register effective chemical controls.

Verticillium Wilt *(Verticillium dahliae)*

Pest Information

Damage: *Verticillium dahliae* invades the xylem and interferes with water transport within the tree, resulting in wilting of foliage and dieback of branches. Affected sapwood becomes dark stained and trees up to four years old often die. Mature trees develop dieback and reduced yields.

Life Cycle: *V. dahliae* is a soil borne organism that infects the roots and invades the vascular system of the tree. The pathogen produces resistant structures (microsclerotia) that can survive in the soil for many years in the absence of hosts.

Pest Management

Cultural Controls: Growing several seasons of grass/green manure crops can reduce inoculum levels. Orchards should not be planted where susceptible crops have been planted previously. Maintenance of adequate soil fertility, soil moisture levels and other methods of reducing stress will help trees tolerate the disease.

Resistant Cultivars: None identified.

Chemical Controls: Inoculum levels can be reduced by fumigating the soil between plantings. Fumigants registered for control of verticillium wilt are listed in *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Verticillium Wilt

1. With the practice of planting low growing crops between the rows in young peach orchards becoming more popular, studies are required to determine whether some inter-planted crops (tomato, pepper, eggplant, strawberry and melon) increase the potential for verticillium wilt in peaches.

Crown Gall *(Agrobacterium tumefaciens)*

Pest Information

Damage: The pathogen induces the formation of galls on the surface of roots or on the crown. The galls interfere with the normal flow of water and nutrients. Young trees may be killed while older trees suffer reduced growth and vigour.

Life Cycle: The pathogen affects a wide range of broadleaf woody plants, including stone fruits. Bacteria are released into the soil when galls are wet or when older gall tissue disintegrates. The bacterium can survive in the soil for at least one year in the absence of host tissue. Established trees are infected only through wounds, such as those caused by growth cracks, pruning, damage from cultivation equipment or freezing injury. Seedlings can be infected during germination if planted into infested soil.

Pest Management

Cultural Controls: Site selection and using disease free planting stock raised in sterile planting media in the nursery are important considerations.

Resistant Cultivars: None identified.

Chemical Controls: Refer to *Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada.*

Issues for Crown Gall

None identified.

Phytophthora Root Rot and Crown Rot (*Phytophthora* spp.)

Pest Information

Damage: Phytophthora root and crown rot is characterized by a decay of the roots and crown tissues. Peach, apricot, nectarine and cherry can be seriously affected. The disease interferes with the uptake and translocation of water and nutrients. The disease may reduce growth and vigour or can progress rapidly resulting in death of the tree. The disease can severely affect the establishment of new plantings at some sites.

Life Cycle: The disease is more of a problem on heavy, wet soils with poor drainage. The pathogen remains in soil as resting spores (oospores or chlamydospores). The fungus is carried from place to place on infected plants, in contaminated soil or in surface water. In saturated soils the disease spreads by the production of mobile zoospores which are able to move long distances in ground water and runoff. Under saturated soil conditions, the spores germinate and infect the roots and the bark of the crown. The fungus develops within the bark, cambium and young xylem tissue, killing the colonized host tissues as it advances.

Pest Management

Cultural Controls: The planting of trees on sites that are well-drained and have sandy loam soil will reduce the chances of disease development. Managing irrigation so that prolonged periods of saturated soils are avoided will result in conditions less favourable for disease development.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Phytophthora Root Rot and Crown Rot

1. An economical and quick diagnostic test is required for the identification of phytophthora root and crown in the field.
2. The development of a strategy for the management of trees affected by phytophthora root and crown rot is required.

Plum Pox Virus (Sharka) (PPV)

Pest Information

Damage: Plum pox is a serious virus disease that infects peach, plum, nectarine, apricot, almond, cherry, as well as some ornamentals and wild prunus species. Disease symptoms vary with host species and cultivar. Symptoms may develop on leaves or fruits, on a portion of a tree or on a single branch. Fruit infections may appear as chlorotic spots or rings and deformation with internal browning of flesh and pale rings or spots on the stones. Infected trees are not killed but become unproductive.

Life Cycle: The pathogen is spread in the nursery by grafting infected buds or scions. It is spread in the field by aphids. Long distance spread is via the movement of infected plant material such as nursery trees, bud wood or scion wood. It is not spread by mechanical means such as pruning.

Pest Management

Cultural Controls: Planting only virus-free, certified nursery stock will prevent the introduction of the disease into new areas. Avoiding growing susceptible trees within a plum pox infected zone helps to prevent new infections. Annual testing of mother trees for the presence of plum pox by laboratory analysis (ELISA and PCR) of tissue samples and the elimination of infected trees will help to maintain a virus-free orchard. Control can be maintained by monitoring, sanitation and quarantine, avoiding introduction and preventing the movement of material out of an infected area. When the virus is detected, eradication by removing infected trees is necessary. Foliar oil sprays may reduce virus transmission by aphids.

Resistant Cultivars: No natural resistance has been found.

Chemical Controls: There are no anti-virus treatments that can be applied to infected trees. Insecticide programs controlling aphid vectors do not prevent the spread of plum pox virus.

Issues for Plum Pox Virus

1. The initial screening and compensation program for plum pox virus will end in 2016, and it is anticipated there may be a continued need for surveillance and grower compensation for lost production caused by this regulated disease.
2. There is a need to develop varieties resistant to plum pox virus.

Rhizopus Rot (*Rhizopus* spp.)

Pest Information

Damage: The disease causes a soft rot of harvested or over-ripe stone fruits. Lesions may be difficult to distinguish from early brown rot lesions. At warm temperatures, the fungus rapidly advances, causing the loss of many peaches within the shipping container.

Life Cycle: Rotted fruit on the orchard floor allow for inoculum build up as the season progresses. In the early stages of fruit ripening, injuries such as those caused by insects, hail, or cracking are required for infection. After harvest, injuries are not required for infection on ripe fruit and rhizopus rot can spread from fruit to fruit at contact points.

Pest Management

Cultural Controls: The fungus does not grow at temperatures below four degrees centigrade, so storing fruit at this temperature will stop the progress of the disease. Careful handling of fruit to avoid wounding will minimize potential sites of infection. Sanitation practices including maintaining cleanliness of storage containers, warehouses and hydro-cooling water and the proper disposal of culled fruit will reduce sources of disease.

Resistant Cultivars: None identified.

Chemical Controls: There are no fungicides registered for post-harvest use.

Issues for Rhizopus Rot

None identified.

Insects and Mites

Key issues

- The spotted wing drosophila (SWD) is a serious threat to all stone fruit crops. Permanent registrations of products currently available only through emergency use registrations are required for consistent management of this pest. Additional research to discover and develop sustainable, long-term management strategies which are compatible with integrated pest management (IPM) programs is needed.
- There are concerns over the potential development of resistance to insecticides used for the management of a number of orchard pests including oriental fruit moth, plum curculio and obliquebanded leafroller. There is a need for the registration of alternative products with different modes of action and for continued education of growers regarding the proper timing of applications and need for rotation of products.
- Mating disruption approaches have been developed and are increasingly being used for management of pests including oriental fruit moth, obliquebanded leafroller and peach tree borers. There is a need for additional pest management tools, including monitoring and decision support tools and IPM compatible insecticides, to support and complement these mating disruption programs.
- There is a concern that the widespread use of mating disruption-based IPM programs may result in increased pest pressure from aphids, tarnished plant bug, San Jose scale and Comstock mealybug. There is a need for the development of robust IPM strategies including monitoring, economic thresholds and cultural and biological controls to address these pest species.
- Research is needed to determine how new trap monitoring methods can be used effectively to aid in early warning and timing of sprays for plum curculio and to develop better monitoring methods and an economic threshold for peach silver mite.
- Pest management research into control strategies and orchard monitoring protocols for brown marmorated stink bug (BMSB) must be in place prior to this pest becoming a problem in commercial orchards. Permanent registrations of products currently available only through emergency use registrations are required for predictable access to control options for this pest.
- There is a need for additional registration of products for the control of Comstock mealybug. There are concerns that this pest is a major vector of plant viruses in tree fruit and grapes and so careful monitoring and management of this pest is necessary for the on-going sustainability of different locally grown crops.

Table 7. Occurrence of insect pests in peach production in Canada

Insect	British Columbia	Ontario
Oriental fruit moth		
Plum curculio		
Green peach aphid		
Brown marmorated stinkbug		
Tarnished plant bug		
Mites		
European red mite		
Two-spotted spider mite		
Peach silver mite		
Comstock mealybug		
San Jose scale		
Japanese beetle		
Oblique-banded leafroller		
European earwig		
Spotted wing drosophila		
Western flower thrips		
Borers		
(Greater) peach tree borer		
Lesser peach tree borer		
Peach twig borer		
American plum borer		
Spring feeding caterpillar complex		

Widespread yearly occurrence with high pest pressure.

Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.

Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.

Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.

Pest is present and of concern, however little is known of its distribution, frequency and importance.

Pest not present.

Data not reported.

[1]Source: Peach stakeholders in reporting provinces.

[2]Please refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 8. Adoption of insect pest management practices in peach production in Canada

	Practice / Pest	Oriental fruit moth	Green peach aphid	Tarnished plant bug	Peach twig borer	Brown marmorated stink bug	Mites
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	choice of planting site						
	optimizing fertilization						
	reducing mechanical damage						
	thinning / pruning						
	trap crops / perimeter spraying						
	physical barriers						
Prevention	equipment sanitation						
	mowing / mulching / flaming						
	modification of plant density (row or plant spacing; seeding rate)						
	seeding depth						
	water / irrigation management						
	end of season crop residue removal / management						
	pruning out / removal of infested material before harvest						
	tillage / cultivation						
	removal of other hosts (weeds / volunteers / wild plants)						
Monitoring	scouting - trapping						
	records to track pests						
	soil analysis						
	weather monitoring for degree day modelling						
	use of portable electronic devices in the field to access pest identification /management information						
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests						

....continued

Table 8. Adoption of insect pest management practices in peach production in Canada (continued)

Practice / Pest		Oriental fruit moth	Green peach aphid	Tarnished plant bug	Peach twig borer	Brown marmorated stink bug	Mites
Decision making tools	economic threshold						
	weather / weather-based forecast / predictive model (eg. degree day modelling)						
	recommendation from crop specialist						
	first appearance of pest or pest life stage						
	observed crop damage						
	crop stage						
Suppression	pesticide rotation for resistance management						
	soil amendments						
	biological pesticides						
	arthropod biological control agents						
	beneficial organisms and habitat management						
	ground cover / physical barriers						
	pheromones (eg. mating disruption)						
	sterile mating technique						
	trapping						
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)						

This practice is used to manage this pest by at least some growers.

This practice is not used by growers to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]Source: Stakeholders in peach producing provinces (British Columbia, Ontario).

Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	R	oriental fruit moth
Bacillus thuringiensis subsp. *kurstaki* strain ABT-351	*Bacillus thuringiensis* and the insecticidal proteins they produce	microbial disruptor of insect midgut membranes	11A	R	leafrollers (fruittree, European, oblique-banded, three-lined), fruitworm
Bacillus thuringiensis subsp. *kurstaki* strain EVB113-19	*Bacillus thuringiensis* and the insecticidal proteins they produce	microbial disruptor of insect midgut membranes	11A	R	leafrollers (fruittree, European, oblique-banded, three-lined), fruitworm
bifenazate	bifenazate	compound of unknown or uncertain mode of action	UN	R	two spotted spider mite, European red mite, Pacific spider mite
carbaryl	carbamate	acetylcholinesterase (AChE) inhibitor	1A	RES*	cat-facing insects, codling moth, European earwig, European fruit lecanium, fruittree leafroller, lesser peachtree borer, oriental fruit moth, peach silver mite, peach twig borer, plum curculio, redbanded leafroller, scale insects
chlorantraniliprole	diamide	ryanodine receptor modulator	28	R	oriental fruit moth, peach twig borer, cherry fruit fly (suppression), leafrollers (obliquebanded, three-lined, redbanded), Japanese beetle (supression)

....continued

Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
chlorpyrifos	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	oriental fruit moth
clofentezine	clofentezine	mite growth inhibitor	10	R	two spotted spider mite, European red mite
clothianidin	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	oriental fruit moth, brown marmorated stink bug (suppression), plum curculio, aphids, leafhoppers
cyantraniliprole	diamide	ryanodine receptor modulator	28	R	oriental fruit moth, obliquebanded leafroller, three lined leafroller, fruittree leafroller, European leafroller, eyespotted budmoth, green peach aphid, plum aphid, cherry fruit fly, western cherry fruit fly, plum curculio, Japanese beetle, spotted wing drosophila, peach twig borer
cypermethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	oriental fruit moth, tarnished plant bug, oak plant bug
deltamethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	peach twig borer, oriental fruit moth
diazinon	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RES*	peach twig borer, San Jose scale, aphids, clover mites, two spotted spider mites,
dimethoate (peaches non-bearing)	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	aphids, mites, tarnished plant bug

....continued

Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
endosulfan	cyclodiene organochlorine	GABA-gated chloride channel antagonist	2A	PO (expiry date of use Dec. 31, 2016)	peach tree borer (root borer), lesser peach tree borer, black cherry aphid, peach silver mite, plum rust mite, green peach aphid, mealy plum aphid, twig borer, tarnished plant bug, stink bug, leafhopper, eye-spotted budmoth
flonicamid	flonicamid	modulator of chlordotonal organs	9C	R	aphids
imidacloprid (post-bloom)	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	aphids (except woolly apple), green peach aphid, leafhoppers,
kaolin	not classified	unknown	N/A	R	plum curculio, codling moth (first generation only), oriental fruit moth, overwintering leafrollers (especially obliquebanded leafroller), leafhoppers, apple maggot, cherry fruit flies, tarnished plant bug
lambda-cyhalothrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	green peach aphid, oriental fruit moth, tarnished plant bug
lime sulphur or calcium polysulphide	not classified	unknown	N/A	R	San Jose scale, European scale, twig borer
malathion	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	R	mites, oriental fruit moth, plum curculio, mealy plum aphid, black cherry aphid

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Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
methoxyfenozide	diacylhydrazine	ecdysone receptor agonist	18	R	obliquebanded leafroller, threelined leafroller, peach twig borer, oriental fruit moth,
methyl bromide (fumigant, pre-plant soil application)	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	insects, weeds, nematodes and other soil-borne pests
methyl bromide + chloropicrin (pre-plant soil fumigant)	alkyl halide + chloropicrin	miscellaneous non-specific (multi-site) inhibitor + miscellaneous non-specific (multi-site) inhibitor	8A + 8B	PO + RES*	insects, nematodes, soil-borne fungi and certain weeds
mineral oil	not classified	unknown	N/A	R	cottony peach scale, San Jose scale, European red mite
novaluron	benzoylurea	inhibitor of chitin biosynthesis, type 0	15	R	orientale fruit moth, peach twig borer, obliquebanded leafroller,
permethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	oriental fruit moth, plum curculio, plant bugs,

....continued

Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
phosmet	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	plum curculio, peach twig borer, oriental fruit moth, obliquebanded leafroller, tarnished plant bug, eastern tent caterpillar, elm spanworm, gypsy moth, Japanese beetle, spring cankerworm, spotted wing drosophila, suppression of European red mite and two spotted spider mite
potassium salts of fatty acids	not classified	unknown	N/A	R	aphids, mites, earwigs, mealybugs, psyllids, sawfly larvae (pear slugs), scale insects, spider mites
pyridaben (Ontario only)	METI acaricide and insecticide	mitochondrial complex I electron transport inhibitor	21A	RE	mites
spinetoram	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activator	5	R	oriental fruit moth, obliquebanded leafroller, threelined leafroller
spirodiclofen	tetronic and tetramic acid derivative	inhibitor of acetyl CoA carboxylase.	23	R	European red mite, two spotted spider mite, McDaniel spider mite, peach silver mite
sulfoxaflor	sulfoxaflor	nicotinic acetylcholine receptor (nAChR) agonist	4C	R	green peach aphid, mealy plum aphid, black cherry aphid, San Jose scale

....continued

Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
sulfoxaflor + spinetoram	sulfoxaflor + spinosyn	nicotinic acetylcholine receptor (nAChR) agonist + nicotinic acetylcholine receptor (nAChR) allosteric activator	4C + 5	R + R	oriental fruit moth, obliquebanded leafroller, threelined leafroller, green peach aphid, mealy plum aphid, San Jose scale
sulphur	not classified	unknown	N/A	R	rust mites

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of April 13, 2015. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA *re-evaluation notes REV2013-06, Special Review Initiation of 23 Active Ingredients* OR PMRA *Re-evaluation Note REV2014-06 Initiation of Special Reviews: Potential Environmental Risk Related to Peponapis pruinosa Exposure to Clothianidin, Imidacloprid and Thiamethoxam Used on Cucurbits,* RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

[4]Source: Fungicide Resistance Action Committee. *FRAC Code List 2014: Fungicides sorted by mode of action (including FRAC code numbering)* (www.frac.info/) (accessed February 17, 2015).

Table 10. Pheromone products registered on peach in Canada

Product Name[1]	Targeted Pests
Isomate-CM/LR TT	codling moth, obliquebanded leafroller, fruittree leafroller, threelined leafroller, European leafroller,
Isomate-CM/OFM TT	codling moth, oriental fruit moth, lesser apple worm
Isomate DWB	dogwood borer
Isomate-M Rosso Oriental Fruit Moth Pheromone	oriental fruit moth
Isomate-M100 Oriental Fruit Moth Pheromone	oriental fruit moth
Isomate OFM-TT	oriental fruit moth, lesser appleworm
Isomate-P Pheromone	peach tree borer, apple clearwing moth
Isomate CM FLEX	codling moth
Isomate-PTB Dual	peach tree borer, lesser peach tree borer
Semios OFM Plus	oriental fruit moth

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all pheromone products registered as of June 29, 2015. The product label is the final authority on use and should be consulted for application information. The information in this table should not be relied upon for pheromone application decisions and use.

Oriental Fruit Moth (OFM) (*Grapholita molesta*)

Pest Information

Damage: Oriental fruit moth larvae enter the terminal at the base of young leaves, and tunnel toward the base of the shoot. Infested terminals wilt and die. Heavy twig infestations in nursery stock and new orchards adversely affect the shape of trees. Later generations attack the fruit. During early fruit development, fruit infestations can cause fruit drop. Feeding by later infestations does not cause fruit drop, but results in visible entrance holes in the fruit.

Life Cycle: Full sized larvae form cocoons and overwinter in bark crevices or in fallen fruit in the orchard. The larvae pupate in the early spring and the first adults are seen at the pink to early bloom stage of bud development. Adult moths lay eggs on leaf surfaces. Following hatching, larvae move into terminal shoots to feed. Excessive tree growth or high temperatures during late summer and fall can result in the development of four full generations which can cause losses to later maturing varieties.

Pest Management

Cultural Controls: Pruning to facilitate good spray penetration and adjusting irrigation schedules to avoid washing off insecticide residue after application will improve chemical control. Pheromone traps can be used to monitor the pest population and determine spray timing. The inter-planting of peach and nectarine with apple or pear will make controls more difficult as the development of OFM differs on these crops. The removal of susceptible hosts within 2.2 km of the orchard will eliminate sources of infestation. Mating disruption with insect pheromones (refer *Table 10. Pheromone products registered on peach in Canada*) under specific conditions is effective for the management of OFM. The economic threshold for fruit moth injury in most commercial peach orchards is < 1% of the total crop infested at harvest.

Resistant Cultivars: None available.

Chemical Controls: Insecticides registered for the control of OFM are listed in *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Oriental Fruit Moth

1. The continued education of growers on the importance of proper insecticide timings and product rotations is required to minimize the risk of the development of resistance in oriental fruit moth populations.

Plum Curculio *(Conotrachelus nenuphar)*

Pest Information

Damage: The plum curculio attacks peach, nectarine, plum, apple, cherry, apricot, pear and quince. Overwintered adult beetles attack fruit soon after it forms, eating holes through the skin and feeding on the pulp next to the pit. Adults cause the formation of bumps on the fruit by feeding. Females cause crescent-shaped scars when laying eggs and larvae cause internal injuries as they burrow through the fruit, with the result that most of the infested fruit drops during June.

Life Cycle: Adult plum curculios overwinter in plant debris in protected sites near orchards. Eggs are laid on young fruit in the spring. Larvae develop within the fruit and drop to the soil to pupate. Adults emerge in July and August and feed on developing fruit throughout the rest of the season. Beetles are more active on warm, damp, cloudy days and in the centre of thick, heavy trees that provide the appropriate micro-climate. Temperature is the most important factor affecting development, particularly early in the spring.

Pest Management

Cultural Controls: The removal of wild, susceptible hosts around the orchard blocks will help to remove a potential source of infestation. Monitoring methods have been developed that give advance warning to migration into the orchard and injury of fruit.

Resistant Cultivars: Nectarine, plum and apricot fruit are more attractive to the pest than peach, but there are no resistant cultivars.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Plum Curculio

1. There is a need for the registration of products which are not harmful to pollinators for the control of plum curculio.
2. Research is needed to determine how trap monitoring methods can be used effectively to aid in early warning and timing of sprays.

Green Peach Aphid (*Myzus persicae*)

Pest Information

Damage: Aphids feed primarily on the underside of leaves, causing them to curl, become distorted and yellow and drop prematurely. Feeding may also occur on flowers resulting in distortion and drop. Peach fruit is not usually attractive for direct aphid feeding. Cool, cloudy weather in May and June prevents aphids from developing wings and migrating to other hosts, which can lead to substantial stress and stunting of leaves of nectarine and peach, as well as direct damage to nectarine fruit. Aphid feeding results in excretion of honeydew which supports the growth of a black sooty fungus that causes spotting of leaves and fruit. This aphid may also serve as a vector of virus diseases such as plum pox.

Life Cycle: The green peach aphid, native to Europe, is an invasive pest of peach and nectarine throughout North America. It has a diverse host range, including all stone fruits and many ornamental shrubs and vegetables. The insect overwinters as eggs on peach and nectarine. The eggs hatch in the spring as females which develop through several nymphal stages to adults. Subsequent generations develop without mating (parthenogenesis) and bear live young. Through the summer, aphids migrate to other hosts. In the fall they return to peaches where they mate, lay overwintering eggs and die.

Pest Management

Cultural Controls: The wide host range and ability to migrate or to remain resident in the orchard makes control of green peach aphid difficult. Over-fertilization of nitrogen can lead to high populations of aphids. Avoiding excessive growth with balanced fertilization and irrigation is important. Thresholds, based on the number of colonies per tree or the percentage of infested shoots, have been established for insecticide treatments of bearing trees. Beneficial predators and parasite species which can help to keep populations in check include ladybird beetles, lacewings, syrphid flies and chalcid wasps.

Resistant Cultivars: Nectarines are more susceptible than peaches, as the pubescence of peach fruit discourages aphid feeding.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for the control of green peach aphid.

Issues for Green Peach Aphid

1. The green peach aphid is of concern because it is the major vector of the plum pox virus. Chemical control of the aphid may be required when populations are high, until the virus is eradicated.
2. There is concern that with the adoption of mating disruption techniques for the oriental fruit moth and corresponding reduction in pesticide use, there may result a resurgence of aphid pests and an increase in the spread of the plum pox virus.
3. A management strategy is required for green peach aphid, including improved economic thresholds that take into account the overall impact on the tree and fruit quality, the lower tolerance of nectarines due to direct fruit damage and plum pox virus transmission.

Brown Marmorated Stinkbug (BMSB) (*Halymorpha halys*)

Pest Information

Damage: The BMSB has not yet been identified as a pest in crops in Canada, but is of concern as it has caused significant crop injury in other jurisdictions where it is established in agricultural crops. This insect has a broad host range including tree fruit, berries, grapes, ornamentals, grain crops, tomatoes, peppers and sweet corn. Injury is caused by feeding of adults and nymphs. The insect injects saliva with digestive enzymes into the plant and ingests the liquefied plant material. Each feeding puncture results in crop injury.

Life Cycle: The BMSB spreads through natural means and also as a "hitchhiker" in cargo and vehicles. It has been intercepted in many provinces over the years and in 2012 an established population was identified in the Hamilton, Ontario area. It readily moves between host crops throughout the growing season. BMSB overwinters as adults. In the spring, adults mate and lay eggs on host plants. Adults are long-lived and females may lay several hundred eggs over an extended period of time. In the fall, the adults move back to protected overwintering sites. They have frequently entered structures in the fall where they are a nuisance pest.

Pest Management

Cultural Controls: Monitoring for the insect may be done through aggregation pheromones and by scouting. Although thresholds have not been established, small numbers of nymphs and adults can cause considerable damage in a growing season.

Resistant cultivars: None available.

Chemical controls: Pesticides registered for the management of BMSM are listed *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Brown Marmorated Stinkbug

1. There is great concern regarding BMSB in Ontario. Although there has been no fruit damage to date, there are healthy colonies in proximity to main peach production areas which have the potential to quickly migrate into commercial areas. Careful monitoring and the development of control strategies need to remain of high importance and must be available prior to this pest becoming a problem.
2. The full registration of emergency products is essential for long term control of this pest.

Tarnished Plant Bug (TPB) (*Lygus lineolaris*)

Pest Information

Damage: The tarnished plant bug attacks buds, flowers and fruit. It feeds by piercing the plant and sucking sap. Prior to shuck split, feeding causes bud, flower or fruit drop. Feeding prior to pit hardening will cause young fruit to become deeply injured and deformed. As the fruit matures after pit hardening, additional injury can appear.

Life Cycle: The tarnished plant bug is a general feeder on many wild and cultivated herbaceous plants, especially legumes, where both adults and nymphs can be found. Only adults are found on peaches and nectarines. Resident populations overwinter and subsequent generations develop on ground cover in the orchard. Migratory populations move into orchard blocks when food sources dry up and hot, humid conditions encourage dispersal.

Pest Management

Cultural Controls: Fruit injury and populations within the tree are influenced by ground cover management and the presence of alternate host crops, such as alfalfa. The use of cover crop species that are not hosts to TPB and a trap crop strip which is an alternate host to TBP are effective tools in managing the pest. Ground cover sampling can be used to determine the presence of populations that can move into the peach trees. Flower buds and fruit should be monitored early in the season for signs of feeding. Border sprays are warranted when two percent of fruit collected from the edge of the orchard is damaged. For both migratory and resident populations, complete block sprays are needed when injury reaches two to five percent throughout the block.

Resistant Cultivars: Some varieties incur less damage, but the reasons are unknown.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for tarnished plant bug.

Issues for Tarnished Plant Bug

1. Effective management strategies that include alternative products, biological controls, cultural practices and possible preferred host cover crops, are required to manage the resistance of TPB to commonly used insecticides.
2. There is a concern that the pest has the potential of becoming a major disruptive pest in blocks where chemical insecticides are being reduced in favour of mating disruption technology.

European Red Mite (*Panonychus ulmi*)

Pest Information

Damage: Mites feed on leaves causing a characteristic leaf injury referred to as bronzing. Photosynthesis and the nitrogen content of leaves are reduced. Prolonged feeding causes tree stress and will reduce shoot growth and fruit bud set the following year. Fruit color, soluble solids, firmness, size and weight can be affected.

Life Cycle: European red mites overwinter as eggs on fruit spurs and buds. Overwintered eggs hatch by the end of the bloom period. The mites develop from egg through three nymphal stages to adult and produce six to eight generations per year. Both adults and nymphs cause plant injury. Development is temperature dependent with development being faster during the hot summer months.

Pest Management

Cultural Controls: The use of cover crops on the orchard floor will reduce dusty conditions that favour the build-up of mite populations. Providing sufficient water by following an irrigation schedule will reduce overall stress on the trees and reduce the impact of mite feeding. Annual pruning to allow good air flow and spray penetration along with regular monitoring are helpful in managing pest mite populations. Using a threshold of 10 to 15 mites per leaf for treatment decisions and careful selection of pesticides to avoid those that are harmful to beneficial predatory mite species are important elements of an integrated pest management program for this pest. Naturally occurring predatory mites provide the most effective control of pest mite populations. The main predatory mites are of the family Phytoseiidae.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for pesticides registered for European red mite control.

Issues for European Red Mite

None identified.

Two Spotted Spider Mite (*Tetranychus urticae*)

Pest Information

Damage: Two spotted spider mites feed on the lower surfaces of leaves resulting in a characteristic mottling and bronzing. Photosynthesis and the nitrogen content of leaves are reduced. Injury is more severe under hot dry conditions.

Life Cycle: Two spotted spider mites are dispersed by wind currents and can move into the orchard in late summer following the drying of vegetation on the orchard floor. The mites overwinter as adults under tree bark. Eggs are laid in the canopy in the spring. Following hatch, mites develop through a number of different nymphal stages to become adults. There may be five to nine generations each year.

Pest Management

Cultural Controls: The use of cover crops in the orchard will reduce dusty conditions that are favourable for mite populations. Annual pruning to allow good air flow and spray penetration along with regular monitoring are helpful in managing pest mite populations. Using a threshold of 5 to 10 mites per leaf for treatment decisions and careful selection of pesticides to avoid those that are harmful to beneficial predatory mite species are important elements of an integrated pest management program for this pest. Naturally occurring predatory mites provide the most effective control of pest mite populations. The main predatory mites are of the family Phytoseiidae.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests of peach in Canada*, for information on pesticides available for mite control in peach orchards.

Issues for Two Spotted Spider Mite

None identified.

Peach Silver Mite (*Aculus cornutus*)

Pest Information

Damage: The peach silver mite feeds on the lower leaf surface and tends to congregate around the leaf mid-rib. Light feeding injury is apparent as fine yellow mottling of leaves. Leaves may curl and become silvery green late in the season due to feeding by high populations (200 to 300 per leaf). Combined with drought stress, peach silver mite can impact fruit size on late maturing varieties, decrease fruit buds and reduce tree winter hardiness. The pest is actually beneficial in low numbers because they are an important food source for predatory mites when other pest mites are at low numbers.

Life Cycle: The peach silver mite overwinters under bud scales on the tree and has several generations per year.

Pest Management

Cultural Controls: The use of cover crops in the orchard will reduce dusty conditions that are favourable for mite populations. Annual pruning opens up the tree allowing good air flow and spray penetration. Any pesticides used in the orchard must be chosen carefully to ensure the preservation of predatory mites that are often the most effective control of pest mite populations. The main predatory mites are of the family Phytoseiidae. Regular monitoring is essential during the summer. It is important to irrigate trees post-harvest, if heavy infestations of peach silver mite are present late in the season and if drought conditions persist into September.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for miticides registered for the control of peach silver mite.

Issues for Peach Silver Mite

1. There is a need for improved monitoring methods and economic thresholds for better decision making in the management of the peach silver mite.

Comstock Mealybug *(Pseudococcus comstocki)*

Pest Information

Damage: Fruit hosts of the Comstock mealybug include peach, pear and apple. It is also a pest of several ornamental plants such as catalpa, mulberry and pine. The insect feeds on sap and is found on leaves and fruit. The pest poses economic concerns for the peach and pear processing industry. Because peaches or pears are made into puree or are canned mechanically, infestations can potentially result in unacceptable contamination of the finished product. It may also slow the packing line as hand labour must be used for sorting. Honeydew secreted by the crawlers is a substrate for sooty moulds growing on the fruit surface. These moulds result in a downgrading of the fresh fruit and are an additional cause of economic loss.

Life Cycle: This pest overwinters as eggs in protected areas on the bark and near pruning wounds. The eggs hatch from mid-April to May and crawlers feed on terminal growth and lower leaf surfaces. The insect progresses through three instars prior to pupation and development into the adult stage. Mating occurs in the spring.

Pest Management

Cultural Controls: Proper pruning to allow good air flow and spray penetration is important in managing this pest.

Resistant Cultivars: None identified.

Chemical Controls: There are no insecticides registered for the control of this pest.

Issues for Comstock Mealybug

1. There continue to be concerns that the Comstock mealybug may become more important now that the use of broad-spectrum materials (such as organophosphates) is limited and more pest–specific products are being registered and used. There is a need for the registration of replacement products for the control of this pest.
2. The broad host range and fact that the Comstock mealy bug is a major vector of viruses is of concern. Since typically more than one commodity is grown in most commercial growing areas, careful monitoring and management of this pest is necessary for sustainability among local industries.

San Jose Scale *(Quadraspidiotus perniciosus)*

Pest Information

Damage: Feeding by San Jose scale causes small red spots on fruit and injures the host tree by sap feeding and reducing tree vigour, especially on young trees.

Life Cycle: The insect may have two to three generations per year. The first nymphal stage overwinters on the bark. This stage matures by full bloom the following spring. Mating occurs in late May or early June and females bear live young called crawlers. The scale crawlers find a suitable feeding site, usually in the upper branches. As they grow they secrete a protective scale under which they live.

Pest Management

Cultural Controls: Annual pruning should be done to open up the tree and allow for good air flow and spray penetration. Poor pruning resulting in poor spray penetration may lead to high populations of scale insect in the upper centre of the canopy. There are no economic thresholds for scale insects on fruit, with most growers applying controls the following spring if fruit injury was seen at harvest.

Resistant Cultivars: None identified.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for the control of San Jose scale.

Issues for San Jose Scale

1. The potential for San Jose scale to become a major pest problem, if mating disruption of oriental fruit moth is used on a large scale, is of concern.

Japanese Beetle (*Popillia japonica*)

Pest Information

Damage: Japanese beetle adults feed on tender leaf tissues leaving a network of veins, resulting in browning and drop of severely affected leaves. The beetles may also feed on the fruit of early ripening peaches. Japanese beetles are general feeders and will attack over 300 different plants.

Life Cycle: White grubs, immature stages of Japanese beetle, overwinter in the soil. They resume feeding on plant roots in the spring, pupate and emerge as adult beetles in early July. At this time they begin to feed on plant foliage and mate, with the adult females then returning to the soil to lay eggs. There is one generation per year.

Pest Management

Cultural Controls: Thresholds have not been established for Japanese beetle on peach.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for the control of Japanese beetle.

Issues for Japanese Beetle

1. The distribution of Japanese beetle continues to expand and in Ontario there is a risk for direct damage to fruit at high pressure locations, particularly for early season cultivars. There is a need to register additional chemistries that are effective and provide quick knockdown.

Obliquebanded Leafroller (*Choristoneura rosaceana*) and other Leafroller Species

Pest Information

Damage: Leafroller larvae cause serious injury by webbing a nearby leaf to the surface of the fruit and eating the skin of the fruit.

Life Cycle: The obliquebanded leafroller overwinters as second or third instar (stage) larvae. In spring, larvae feed on leaves and flower buds and on fruit after petal fall. Larvae develop through six instars, before pupating and emerging as adults. Eggs are laid on the underside of leaves. There are two generations per year.

Pest Management

Cultural Controls: Avoiding fertilization and irrigation before the pit hardening stage and minimizing fruit thinning early in the season can be helpful in reducing the impact of this pest. Isolating blocks of sweet cherries, apples and pears from peach to avoid migration of larvae will reduce infestations from other host crops. Monitoring populations in other nearby crops and the use of pheromone trap monitoring for the application of insecticides has been shown to be effective. Mating disruption technology is available for use under select conditions (refer *Table 10. Pheromone products registered on peach in Canada*).

Resistant Cultivars: Varieties prone "to developing split-pits seem particularly susceptible to damage.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Leafrollers

1. Pest resistance to both organophosphate and pyrethroid insecticides has been well documented in apple and pear, and careful monitoring is required to watch for migration of these resistant populations into stone fruit orchards. IPM-compatible, cost-effective products are required to support both IPM and advanced mating disruption programs.

European Earwig *(Forficula auricularia)*

Pest Information

Damage: Earwigs damage peaches by boring into injured, ripening and over-ripened fruit. This feeding damage increases the risk of brown rot infection by wind-borne or water-borne spores. Earwigs may also transfer pathogen spores directly as they feed.

Life Cycle: Earwigs have one generation per year. Adult earwigs overwinter in the soil. Eggs are laid in the soil in the spring and upon hatching, earwig nymphs begin to feed on a variety of materials. Earwigs are very sensitive to sunlight, hiding during the day in sheltered cracks and crevices.

Pest Management

Cultural Controls: Removal of debris and weeds from the base of trees will remove hiding places for this pest. Earwigs can be kept out of trees by wrapping a smooth part of the trunk with an adhesive tape before activity is first noticed. Small boxes stuffed with crumpled paper or rolls of newspaper can be set on the ground to capture earwigs. Tucking newspapers, covered with plastic bags to keep them dry, into limb crotches is a useful way of monitoring them.

Resistant Cultivars: None identified.

Chemical Controls: Foliar sprays applied against other pests will help control earwigs.

Issues for European Earwig

1. There is a need for the registration of reduced risk products for the control of European earwigs.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila (SWD) is known to infest raspberry, blackberry, blueberry, strawberry, cherry, peach, nectarine, apricot and plum as well as numerous wild hosts. Although its presence has been confirmed in peach production areas, to date there have been no reports of fruit damage directly related to SWD. Late season cultivars appear to be at most risk as drosophila populations are higher later in the summer. Unlike other fruit flies, spotted wing drosophila will attack sound fruit. Larvae feed within fruit causing softening and a breakdown of flesh which makes the fruit unmarketable. Wounds caused by egg-laying serve as entry points for disease.

Life Cycle: The insect overwinters as adult flies. In the spring the flies mate and lay eggs under the skin of ripening fruit. Larvae feed and develop within the fruit. The entire life cycle from eggs, through larval and pupal stages to adult, varies between 7 days at 28°C to 50 days at 12°C. Due to the short generation time and extended period of egg laying by adults, there can be several, overlapping generations each year. The insect is spread short distances by wind and can be carried to new areas through the movement of infested fruit.

Pest Management

Cultural Controls: Strict sanitation measures are important in the field and in processing areas. The frequent harvest of all ripe fruit and removal of unmarketable fruit culls from the orchard will help to reduce the chances of the fly infesting the fruit and reduce sources of continued infestations. Flies can be monitored using apple-cider vinegar traps.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for spotted wing drosophila are listed in *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Spotted Wing Drosophila

1. Spotted wing drosophila is a serious threat to all stone fruit crops. Registrations of reduced risk insecticides are required for long term control of this pest. Short pre-harvest intervals are essential as this pest targets fruit that are close to harvest.
2. There is a need for the development of beneficial management practices.

Western Flower Thrips (WFT) (*Frankliniella occidentalis*)

Pest Information

Damage: Scarring develops on the surface of fruit as a result of feeding by thrips from the pink through shuck fall stages of fruit development. The scars enlarge as the fruit grows.

Life Cycle: The WFT feeds on a wide variety of plants. Populations can build up on nearby host species and move into the orchard. Eggs are laid on peach during bloom. Following hatch, nymphs feed for a number of weeks before becoming adults. There are several generations per year.

Cultural Controls: Close examination of blossoms in the early spring is important to monitor for the presence of thrips.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Western Flower Thrips

1. There is a need for further investigation of the presence of this pest in peach/ nectarine orchards during bloom and fruit set periods. There are concerns that some of the fruit surface damage often identified as cold damage is actually thrips damage.

Peach Tree Borer *(Synanthedon exitiosa)*

Pest Information

Damage: The peach tree borer can cause serious damage to cultivated cherry, plum, apricot, peach, nectarine and ornamental shrubs. Larvae feed on the cambium, growing tissues and the inner bark of the tree. Most of the larval activity is confined to the trunk area, from a few inches above the soil line to a few inches below. Larval feeding may completely girdle and kill young trees. Older trees are less likely to be girdled but are often severely injured, making them susceptible to attack by other insects and diseases.

Life Cycle: The adult clear wing moths, present from mid to late summer, lay eggs on the lower trunk and in cracks in soil near peach trees. Following hatching, the larvae bore into the lower trunk and begin to feed. The larvae overwinter in feeding tunnels, complete their feeding and pupate in the spring.

Pest Management

Cultural Controls: Painting trunks of young trees with white latex paint reduces their attractiveness to adult peach borers. Removal of other hosts from surrounding orchard blocks and removal of waste wood from orchard trees can reduce infestation levels. Pheromone traps can be used to time sprays. In British Columbia, well defined thresholds have been worked out. For small plantings, organic blocks or single trees, placing a metal, cone-shaped collar around the base of the tree before eggs are laid prevents larvae from boring into the tree base.

Larvae can also be killed in tunnels by probing with a wire or by opening the tunnels to find and destroy them. Mating disruption technology is available for use under select conditions (refer to *Table 10. Pheromone products registered on peach in Canada*).

Resistant Cultivars: None identified.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for peach tree borer control.

Issues for Peach Tree Borer

1. There is a need to register alternatives to endosulfan (registration expires in 2016) that are compatible with and can be used to support mating disruption programs.
2. There is no longer regional trapping being conducted in Ontario for peach tree borers. As a result, it has been difficult to accurately time insecticide applications targeting this pest. There is a need for additional resources to better track peach tree borer populations, especially in young orchards where mating disruption is not being used.

Lesser Peach Tree Borer (*Synanthedon pictipes*)

Pest Information

Damage: The lesser peach tree borer attacks peach, plum, sweet cherry, tart cherry, apricot and nectarine. Wild crop hosts include wild black cherry, wild red cherry, beach plum, wild plum and Saskatoon berry. The borer attacks the bark of trunks and branches previously injured by pruning, canker diseases or other insects. Larvae feed on the bark at the margins of the injured area, enlarging the wounded area and often girdling and killing the branch. Trees infested by the borer are more susceptible to perennial canker.

Life Cycle: The pest overwinters as larvae under the bark. After a short period of feeding in the spring, mature larvae move to the bark surface where they pupate and eventually emerge as adult moths. Following mating, female moths lay eggs on injured bark tissues. Following hatch, the larvae enter the bark and begin to feed. There is one generation and sometimes a partial second generation per year. The rate of development of this pest is highly temperature dependent.

Pest Management

Cultural Controls: The removal of wood from orchard trees that have been cut may eliminate a source of continued infestation. Mating disruption technology is available for use under select conditions (refer to *Table 10. Pheromone products registered on peach in Canada*). In British Columbia, thresholds based on the number of moths caught per trap per week have been established for chemical treatments.

Resistant Cultivars: None identified.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for lesser peach tree borer control.

Issues for Lesser Peach Tree Borer

1. There is a need to register alternatives to endosulfan (registration expires in 2016) that are compatible with and can be used to support mating disruption programs.
2. There is no longer regional trapping being conducted in Ontario for lesser peach tree borers. As a result, it has been difficult to accurately time insecticide applications targeting this pest. There is a need for additional resources to better track lesser peach tree borer populations, especially in young orchards where mating disruption is not being used.

Peach Twig Borer (*Anarsia lineatella*)

Pest Information

Damage: Larvae of the peach twig borer tunnel into buds and new shoots causing them to wilt and die. Larvae of later generations feed on fruit, creating entry holes near the stem. A gummy exudate is produced on damaged fruit and twigs. Host trees include peach, nectarine, apricot, plum and prune.

Life Cycle: The pest has two generations per year with a partial third generation in some years. Adults are present in May and June and again in late July. Female moths lay eggs on leaves, fruit or twigs and following hatch, larvae feed on plant tissues. Egg hatch of the second generation occurs in late September and larvae feed for a short time before seeking over-wintering sites. Overwintering larvae resume feeding in the spring before pupating and emerging as adults in May.

Pest Management

Cultural Controls: The flight of male moths can be monitored through the use of pheromone traps to help time sprays to control larvae. Sprays can also be timed based on the visual examination of developing shoots, buds and fruit. Thresholds have been established for chemical treatments based on the number of moths caught per trap in a week during the first and the second generations.

Resistant Cultivars: None identified.

Chemical Controls: Refer to *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada*, for insecticides registered for peach twig borer control.

Issues for Peach Twig Borer

1. There is a need to register control products that are compatible with and can be used to support mating disruption programs.

Spring Feeding Caterpillar Complex (Redbanded Leafroller (*Argyrotaenia velutiana*), Variegated Leafroller (*Platynota flavedana*), Fruittree Leafroller (*Archips argyrospila*), Eastern Tent Caterpillar (*Malacosoma americanum*), Forest Tent Caterpillar (*M. disstria*), Eyespotted Bud Moth (*Spilonota ocellana*) and Gypsy Moth (*Lymantria dispar*))

Pest Information

Damage: Caterpillars feed on foliage, blossoms and fruit of peaches in the spring. Larvae of some species web and roll terminal leaves into a protective covering. Early season feeding on fruit may result in the development of corky scars that expand as the fruit grows.

Life Cycle: Spring feeding caterpillars develop through a number of stages: egg, larva, pupa to the adult butterfly or moth. The timing of the life stages differs among species, with some species overwintering as eggs and others as larvae or pupae.

Pest Management

Cultural Controls: These insects are general feeders on a wide variety of broadleaf trees. They tend to be more prevalent on trees towards the outside of the orchard. Monitoring for these insects involves visual examination of new growth.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for the control of various caterpillar species are listed in *Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada.*

Issues for Spring Feeding Caterpillars

None identified.

Weeds

Key Issues

- There is concern that heavy reliance on glyphosate herbicides has led to increased prevalence of resistance in numerous weed species including Canada fleabane, some thistle species and henbit. There is a need for registrations of additional contact herbicides that will reduce reliance on glyphosate based herbicides.
- Reduced-risk residual herbicides with low environmental impact and which can be soil applied, are required. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.
- There is a need for research into innovative weed management methods including flaming, mulches, use of cultivators and for research and development of an integrated weed management program in peaches.
- There is a need to assess environmental impacts of both conventional and alternative weed management tools and approaches.

Table 11. Occurrence of weeds in peach production in Canada

Weed	British Columbia	Ontario
Annual broadleaf weeds		
Perennial broadleaf weeds		
Annual grass weeds		
Perennial grass weeds		
Widespread yearly occurrence with high pest pressure.		
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.		
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.		
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.		
Pest not present.		
Data not reported.		

[1]Source: Peach stakeholders in reporting provinces.

[2]Please refer to Appendix 1, for a detailed explanation of colour coding of occurrence data.

Table 12. Adoption of weed management practices in peach production in Canada

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Avoidance	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
	use of weed-free seed				
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	modification of plant density (row or plant spacing; seeding)				
	seeding / planting depth				
	water / irrigation management				
	weed management in non-crop lands				
	weed management in non-crop years				
	tillage / cultivation				
Monitoring	scouting / field inspection				
	field mapping of weeds / record of resistant weeds				
	soil analysis				
	use of portable electronic devices in the field to access pest identification / management information				
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	economic threshold				
	weather / weather-based forecast / predictive model				
	recommendation from crop specialist				
	first appearance of weed or weed growth stage				
	observed crop damage				
	crop stage				

…continued

Table 12. Adoption of weed management practices in peach production in Canada (continued)

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	arthropod biological control agents				
	habitat / environment management				
	ground cover / physical barriers				
	mechanical weed control				
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				
This practice is used to manage this pest by at least some growers.					
This practice is not used by growers to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

[1]Source: Stakeholders in peach producing provinces (British Columbia, Ontario).

Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Fumigant, pre-plant soil application					
methyl bromide	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	insects, weeds, nematodes and other soil-borne pests
methyl bromide + chloropicrin	alkyl halide[4] + chloropicrin[4]	miscellaneous non-specific (multi-site) inhibitor[4] + miscellaneous non-specific (multi-site) inhibitor[4]	8A[4] + 8B[4]	PO + RES*	insects, nematodes, soil-borne fungi, certain weeds
Hooded sprayer application					
carfentrazone-ethyl	triazolinone	inhibition of protoporphyrinogen oxidase (PPO)	14	R	many broadleaf weeds
Nursery stock					
napropamide	acetamide	inhibition of VLCFA (inhibition of cell division)	15	R	annual grasses and broadleaf weeds
First year/ newly planted trees					
bentazon (bendioxide)	benzothiadiazinone	inhibition of photosynthesis at photosystem II	6	R	many broadleaf weeds, yellow nutsedge, cleavers, stork's bill, volunteer canola
simazine and related triazines	triazine	inhibition of photosynthesis at photosystem II	5	RES	lady's-thumb, lamb's-quarters, purslane, ragweed, wild buckwheat, smartweed, volunteer clovers, barnyard grass, crabgrass, wild oats, yellow foxtail, perennial species starting from seed
trifluralin	dinitroaniline	microtubule assembly inhibition	3	RES	most annual grasses and many broadleaf weeds

....continued

Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Established trees					
2, 4-D	phenoxy-carboxylic-acid	action like indole acetic acid (synthetic auxins)	4	RES	annual and perennial broadleaf weeds
dichlobenil	nitrile	inhibition of cell wall (cellulose) synthesis	20	RES	annual bluegrass, crabgrass, foxtail, quackgrass, sedges, *Juncus* spp., horsetail, many annual broadleaf weeds, certain broadleaf perennial weeds
fluazifop-P-butyl	aryloxyphenoxy-propionate 'FOP'	inhibition of acetyl CoA carboxylase (ACCase)	1	RES	grass weeds
glufosinate ammonium	phosphinic acid	inhibition of glutamine synthetase	10	R	common chickweed, green foxtail, lamb's-quarters, stinkweed, wild mustard, redroot pigweed, dandelion, oak-leaved goosefoot, wild buckwheat
indaziflam	alkylazine	cellulose inhibitor	29	R	annual grasses and broadleaf weeds
linuron	urea	inhibition of photosynthesis at photosystem II	7	RES*	most annual grasses, broadleaved weeds

.... continued

Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
New plantings and established trees					
flumioxazin	N-phenylphthalimide	inhibition of protoporphyrinogen oxidase (PPO)	14	R	certain annual broadleaf weeds, green foxtail, dandelion
glyphosate	glycine	inhibition of EPSP synthase	9	RE	annual and perennial weeds
metribuzin	triazinone	inhibition of photosynthesis at photosystem II	5	R	certain annual grasses and broadleaf weeds
paraquat	bipyridylium	photosystem-I-electron diversion	22	RES	grasses and broadleaf weeds
pendimethalin	dinitroaniline	microtubule assembly inhibition	3	R	germinating annual grasses and broadleaf weeds
s-metolachlor and R-enantiomer	chloroacetamide	inhibition of VLCFA (inhibition of cell division)	15	R	annual grasses and broadleaf weeds
sethoxydim	cyclohexanedione 'DIM'	inhibition of acetyl CoA carboxylase (ACCase)	1	R	annual grasses, wild oats, volunteer cereals, quackgrass

.... continued

Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
New plantings and established trees (continued)					
terbacil	uracil	inhibition of photosynthesis at photosystem II	5	R	annual weeds

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of April 14, 2015. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Herbicide Resistance Action Committee (HRAC). *Classification of Herbicides According to Site of Action (2014)* (www.hracglobal.com) (accessed February 17, 2015). Herbicide resistance groups are based on the Weed Science Society of America classification system as reported by HRAC.(www.hracglobal.com).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA Re-evaluation note REV2013-06, Special Review Initiation of 23 Active Ingredients, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

[4] Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

Weeds

Pest Information

Damage: A 50% reduction in tree trunk diameter may occur in areas where weeds are not controlled. Newly planted trees do not compete well with large annual weeds. New trees will lose a year's growth if competition is intensive and can be killed if water or nutrients are a limiting factor. Losses on larger trees manifest as smaller fruit due to competition and in reduced fruit bud set for the next season. Losses can be as high as 50% depending on the rootstocks and weeds involved. Perennial weeds that have been established for several years can become very large and consequently be very competitive.

Life Cycle: Most arable land is infested with weed seeds at all times. For new peach plantings, the critical period for control is during May and June. For bearing trees, the critical period is from bud-break until 30 days after bloom. The critical weed-free period means that no yield reduction will result if the crop is kept free of weeds during this time. Weeds emerging after that period will not affect yield, however control efforts at that time help make harvest more efficient and reduce weed problems in subsequent years.

Annual weeds: Annual weeds complete their life cycle, from seed germination through vegetative growth and flowering, to seed production, in one year. Many weeds in fruit crops are winter annuals; plants that begin their growth in the fall, produce a rosette of leaves in the fall and flower the second year. Spring annual weeds germinate in the early spring, grow during May and June and produce seeds in the summer for the next year. Annual weeds are very successful at reproducing by seed. They produce large numbers of seeds and some weed seeds remain viable in the soil for many years, germinating when conditions are right.

Biennial weeds: Biennial weeds germinate in the spring and remain vegetative during the first summer. They over-winter as rosettes and then in the second growing season they bolt, sending up a flower stock on which seeds are produced. The original plants die at the end of the second growing season.

Perennial weeds: Perennials are plants that live for many years. They spread through the expansion of various types of root systems and other vegetative means and by seeds.

Pest Management

Cultural Controls: The management of surrounding fields, ditch and road areas by regular cultivation, fallowing and/or mowing to prevent flowering of weeds helps keep the seed bank of weeds lower in the soil. The use of a clean, seed–free source of mulch and manure prevents the introduction of additional seeds and new species. A green manure crop, combined with fallow periods, can stimulate weed seed germination and deplete the weed seed bank in the soil. Site preparation may also involve planting a green manure crop such as rye-grass or Sudan grass the year before planting the orchard and using non selective herbicides for broadleaf weeds in the green manure cropping system. Biodegradable plastic mulch or straw mulch can be used to cover the soil. Establishing sod cover the year before planting and then planting into the sod that has been killed, will reduce the need for herbicides in the year of planting. Weed whippers and mowers that cut close to the trees without injury are helpful, but mowing on its own will not completely eliminate weed competition. The establishment of a vigorous sod growth between tree rows will reduce weed pressure. Hand removal of new weed species or resistant biotypes may be an important method of preventing them from becoming established.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 13. Herbicides and bioherbicides registered for weed management in peach production in Canada,* for chemicals registered for weed control in peach.

Issues for Weeds

1. There is concern that heavy reliance on glyphosate herbicides has led to resistance in Canada fleabane, select thistle species, henbit and other plant species. Weed species that are tolerant to glyphosate are becoming more prevalent. There is a need to register additional contact herbicides that are effective on a large range of broadleaf weeds and grasses in order to reduce the use of glyphosate.
2. The registration of herbicides of new chemical groups is required for resistance management.
3. Reduced risk replacements are required for soil-applied, residual herbicides with harsh environmental profiles (toxicity to soil biota, tendency for leaching, ground water contamination and soil persistence).
4. The development of an integrated approach to weed management in peaches is required.
5. There is a need for the development and assessment of the environmental impact of innovative methods of weed control in peaches such as flaming, development and use of low cost mulches and mulch application and cultivators.
6. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.

Vertebrate Pests

Deer, birds, rabbits, mice (voles), woodchucks (groundhogs) and bears can damage peach orchards. Damage includes direct feeding on fruit, injury to trees by feeding on buds or broken tree limbs, girdling of the bark, feeding on roots, as well as a possible bacterial contamination of fruit by bird droppings and subsequent food safety issues.

Chemical control, in the form of rodenticide baits, is an option for mice. Repellents to keep deer and bear away include ammonium soaps and putrescent whole egg solids.

The control of most vertebrate pests is based on a combination of cultural practices and preventative techniques in a season-long management strategy to reduce economic losses. Keeping orchard grass short and herbicide strips free of weeds will reduce damage by mice. Mowing of the orchard sod also makes it easier for predators such as foxes and hawks to hunt voles. Removing straw, weeds and sod from around the base of trunks reduces habitat for rodents and discourages mouse establishment. Picking up fruit that has fallen to the ground in the fall discourages deer and rabbits. Wire mesh tree guards will help prevent voles from girdling trees. Yellow tapes or streamers act as a visual repellent for birds and can be used in conjunction with noisemakers, such as cracker or whistler shells, propane exploders or electronic alarms. The broadcasting of distress calls and the use of scarecrows and predator models, such as hawk-shaped kites, will repel birds. Woven wire fencing or electric fencing will help keep deer and bears out of orchards.

Resources

IPM/ICM resources for production of peach in Canada

Websites

British Columbia Ministry of Agriculture, Food, and Fisheries. Tree Fruit Publications.
http://www.agf.gov.bc.ca/treefrt/

Health Canada, Pest Management Regulatory Agency
http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php

Ontario Ministry of Agriculture, Food and Rural Affairs, Crop Publications
http://www.omafra.gov.on.ca/english/crops/publications.html

Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Crop IPM
http://www.omafra.gov.on.ca/IPM/english/index.html

Publications

Agnello, A., Chouinard, G., Firlej, A., Turechek, W. Vanoosthuyse and C. Vincent. 2006. *Tree Fruit Field Guide to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America*. Plant and Life Sciences Publishing, Ithaca, New York. 238pp.

British Columbia Ministry of Agriculture and British Columbia Fruit Growers' Association. *2010 Integrated Fruit Production Guide for Commercial Tree Fruit Growers, Interior of British Columbia*. http://www.agf.gov.bc.ca/cropprot/prodguide.htm

British Columbia Ministry of Agriculture. *Tree Fruit Insect Pests and Diseases*
http://www.agf.gov.bc.ca/cropprot/tfipm/treefruitipm.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 360, Guide to Fruit Production 2014-15, 310 pp.* http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 360, Guide to Fruit Production 2014-15, January 2015 Supplement.* 16pp.
http://www.omafra.gov.on.ca/english/crops/pub360/sup/pub360sup.pdf

Philip, Hugh and Linda Edwards. 1991. *Harmful and Beneficial Insects and Mites of Tree Fruits*, 3rd ed. British Columbia Ministry of Agriculture.
http://www.agf.gov.bc.ca/cropprot/fieldguide/main.htm

Provincial Crop Specialists and Provincial Minor Use Coordinators.

Province	Ministry	Crop Specialist	Minor Use Coordinator
British-Columbia	British Columbia Ministry of Agriculture and Lands www.gov.bc.ca/al	Jim Campbell Jim.g.campbell@gov.bc.ca	Caroline Bédard caroline.bédard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca	Wendy McFadden-Smith wendy.mcfadden-smith@ontario.ca	Jim Chaput jim.chaput@ontario.ca

National and Provincial Fruit Grower Organizations

British Columbia Fruit Growers Association (www.bcfga.com)

Canadian Horticultural Council (www.hortcouncil.ca)

Ontario Fruit and Vegetable Growers Association (www.ofvga.org)

Appendix 1

Definition of terms and colour coding for pest occurrence table of the crop profiles.

Information on the occurrence of disease, insect, mite and weed pests in each province is provided in Tables 4, 7 and 11 of the crop profile, respectively. The colour coding of the cells in these tables is based on three pieces of information, namely pest distribution, frequency and importance in each province as presented in the following chart.

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th rowspan="2">Colour Code</th></tr>
<tr><th></th><th></th><th>Frequency</th><th>Distribution</th><th>Pressure</th></tr>
<tr><td rowspan="11">Present</td><td rowspan="9">Data available</td><td rowspan="4">Yearly - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">Widespread - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>High - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.</td><td>Red</td></tr>
<tr><td>Moderate - If present, potential for spread and crop loss is moderate; pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>Low - If present, the pest causes low or negligible crop damage and controls need not be implemented.</td><td>Yellow</td></tr>
<tr><td rowspan="3">Localized - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="5">Sporadic - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">Widespread - as above</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>Yellow</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="3">Localized - as above</td><td>High - see above</td><td>Yellow</td></tr>
<tr><td>Moderate -see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data not available</td><td colspan="3">Not of concern: The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">Is of concern: The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td></td></tr>
<tr><td>Not present</td><td colspan="4">The pest is not present in commercial crop growing areas of the province, to the best of your knowledge.</td><td>black</td></tr>
<tr><td>Data not reported</td><td colspan="4">Information on the pest in this province is unknown. No data is being reported for this pest.</td><td>grey</td></tr>
</table>

References

American Phytopathological Society, *Compendium of Stone Fruit Diseases*. 1995. ISBN 0-89054-174-4. Item # 41744.

British Columbia Ministry of Agriculture, Food, and Fisheries. *Tree Fruit Insect Pests and Diseases*. British Columbia Ministry of Agriculture, Food and Fisheries. Available at: http://www.agf.gov.bc.ca/cropprot/tfipm/treefruitipm.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 360, Guide to Fruit Production 2014-15, 310 pp.* http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

Ontario Ministry of Agriculture and Food. Factsheet and tender fruit pest management information on web. http://www.omafra.gov.on.ca/english/crops/hort/tender_fruit.html

Ontario Ministry of Agriculture and Food.1992. *Factsheet: Soil Management for Orchards and Vineyards*. http://www.omafra.gov.on.ca/english/crops/facts/92-120.htm

Philip, H.G. and L. Edwards. 2001. *Harmful and Beneficial Insects and Mites of Tree Fruits.* British Columbia Ministry of Agriculture, Food and Fisheries. http://www.agf.gov.bc.ca/cropprot/fieldguide/main.htm

Pennsylvania State University. 2001. *Pennsylvania Tree Fruit Production Guide, 2002-2003.* College of Agricultural Sciences, Pennsylvania State University. Available at: http://tfpg.cas.psu.edu/ Accessed on: July 10, 2002

Childers, N.F. J.R. Morris and G.S. Sbbett 1995. *Modern Fruit Science*, Pub. Horticulture Pub. 3906 NW 31 Place; Gainesville, Flordia 32606; Pages 274-292.

Canadian Food Inspection Agency. Plum Pox Virus; http://www.inspection.gc.ca/plants/plant-protection/diseases/plum-pox-virus/eng/1323888514908/1323889333540

Jones, A.L. and T. B. Sutton. *Diseases of Tree Fruits in the East*. 1996. Michigan State University Cooperative, Extension NCR 45. 95 pp.

University of California. 1999. *Integrated Pest Management For Stone Fruits*. Publication 3389. 264 pp. http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_stonefruits.html

West Virginia University, Index of Fruit Disease:
http://www.caf.wvu.edu/kearneysville/wvufarm8.html